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INFORMATION ON OPPORTUNITIES FOR PREPARATORY TRAINING OF SCIENTIFIC RESEARCH WORKERS IN THE USSR AND STIPENDS AVAILABLE FOR THE PURPOSE OF EXPANDING COOPERATION IN THE PEACEFUL USES OF OUTER SPACE

Working paper submitted by the USSR

I. List of educational and scientific research institutions in the USSR which have expressed willingness to participate in international educational cooperation

1. Moscow State University (Lomomovskiy University) (MSU).
2. Moscow State University Shternberg State Astronomy Institute (SHAI MSU).
3. Bauman Moscow State Technical University (MSTU).
4. Moscow Aviation Institute (MAI).
5. Moscow Energy Institute (MEI).
6. Special Construction Office of Moscow Energy Institute (SCO MEI).
7. Moscow Timber Technology Institute (MTTI).
8. Leningrad Mechanical Institute (LMI).
9. Kharkov State University (KHSU).
10. Kharkov Aviation Institute (KHAI).

11. Dnepropetrovsk State University (DSU).

12. Moscow Oil and Gas Institute (MOGI).

13. Moscow State University Scientific Research Institute for Nuclear Physics (SRINP MSU).

14. Leningrad State University (LSU).

15. Saratov State University (SSU).

16. Moscow Physical and Technical Institute (MPTI).

17. Moscow Aviation Technology Institute (MATI).

18. Moscow Institute of Geodetic Engineering, Aerial Photography and Cartography (MIGIAC).

19. Gorky Scientific Research Institute for Radiology (GSRIR).

20. Moscow Institute for Electronic Machinery (MIEM).

21. Kuibyshev Aviation Institute (KAI).

22. Tomsk Polytechnical Institute (TPI).

23. Kazan Aviation Institute (KAI).

24. "Orbit" Special Construction and Technology Office of Novocherkask Polytechnic Institute ("Orbit" SCTO NPI).

25. Moscow Institute for Radio Technology, Electronics and Automation (MIREA).

26. Moscow Institute of Biotechnology (MIBT).

II. FIELDS AND NATURE OF COOPERATION OFFERED

1. Research and applied work in the fields of:

1.1. Design of next-generation automated space apparatus for research on the sun and the planets of the solar system (MIA).

1.2. Development of technology, equipment and instruments for assembly, mounting and repair of space objects in orbit and on other planets (MIA). Problems of orbital space stations and large-scale space construction (LMI).

1.3. Design of satellite systems for active functioning of at least 10 years (MIA).

1.4. Design of automated space apparatus and systems, including construction from composite materials (LMI).

1.5. Methods of space research on natural resources on Earth (LSU, MIGEAC, GSRIR, KAI, MTTI, MOGI, MSU).

1.6. Remote sensing from space for ecological monitoring for environmental preservation of the Earth's surface (preparation of thematic natural maps of specific regions for different purposes: geological, geomorphological, soil, vegetation, etc.) and research on the evolution of solar bodies (Moon, Mars, Mercury, Venus) from the comparative planetological point of view (MSU, MTTI, MIGEAC, GSRIR, LSU, SSU, SCO MEI).

1.7. Development and construction of space systems for research on the Earth's atmosphere and surface for national economic purposes (MSTU).

1.8. Development of methods and means for ecological monitoring of the physical composition of the Earth's surface and atmosphere (high-level profiles of temperature, pressure and humidity, cloud composition, sea and ocean surface temperature, presence of oil pollution) on the basis of measurements from the Earth's surface and from aerospace platforms of spontaneous radiation from the Earth's surface by microwave wave-length range (GSRIR).

1.9. Environmental pollution from space apparatus - research on the dissemination and effect of pollutants in space and the atmosphere. Development of methods and equipment for detection of the dissemination of ecologically harmful products from rocket engine combustion in space and the atmosphere (MSTU).

1.10. Design of engines utilizing fuel with ecologically clean combustion products. Experimental research on combustion chambers in Earth conditions and experiments in outer space (MSTU).

1.11. Research on and development of closed gas-turbine motors (CGTM) utilizing solar, nuclear and radioisotope energy sources from future orbital stations, multi-purpose orbital apparatus and geostationary systems linked with interplanetary space apparatus (MUTU).

1.12. Space radiotechnology complexes and the construction of installations utilizing them (LMI).

1.13. Management of space materials, research on the effect of space factors on materials and construction (LMI, MPTI, MATI, MIAN, KAI, LSU, TPI).

1.14. Problems of the development of national economic production on the basis of the achievements of astronauts (LMI).

1.15. Research, development and construction of automated biotechnical apparatus and closed automated complexes for the production of new drugs and medical preparations in sustained microgravitational conditions (MSTU).

1.16. Astronomical research (SHAI MSU, KHSU).

1.17. Research on the ionosphere (KHSU).

1.18. Asteroid research (KHSU in cooperation with United States scientific organizations).

1.19. Construction of specialized simulators for off work and maintenance of the skills of spacecraft crews in real time ("Orbit" SCTO NPI).

1.20. Development of scientific and methodological bases of radio-astro-space metrology on the basis of radio interferometry from ultra-long sources (RULS) for space navigation, geodesy and time-coordination insurance (limb measurement (GSRIR)).

1.21. Research on the spectral, temporal and spatial characteristics of fluctuations of amplitude, phase and angle in ultra-short wave radio signals in the 0.1-10.0 ITT range after travel through atmospheric and ionospheric turbulence in polar, temperate and equatorial latitudes in order to predict the influence of turbulence on space systems in connection with the development of recommendations for space-linked systems at low angles to the horizon (GSRIR).

1.22. The use of low-power (1.0 BT) ionoprobes with continuous emission of specially modulated linear signals in the 1-60 NGT range aboard space apparatuses for the organization of transionospheric probes for the prediction and global control of natural and artificial ionospheric disturbances in order to construct adaptive systems for long-range KB and UKB links (GSRIR).

1.23. The conduct of experiments in space with electron-cluster instruments for the prediction of earthquakes, tornadoes and other atmospheric catastrophes (MIREA).

1.24. Research, development and testing in natural condition of powerful modular laser semiconductor measuring instruments for high-resolution optical space links and monitoring (MIREA).

1.25. Research on technological methods for the production of traditional forms of food for astronauts in space conditions (MIBT).

1.26. The development and production of systems for the ISZ "Meteor" and NOAA type reception of information for the daily charting of subsurface and surface water conditions, nightly measurement of water temperature, nightly regional charts of subsurface water temperature, normal ozone concentration, the water steam content and other characteristics of the atmosphere, and the measurement of selective atmospheric absorption for the determination of stratospheric temperatures (MPTI).

2. In addition, scientific contacts and the exchange of information could be carried out in the following areas:

- The development of new designs for large-scale space constructions, the principles of their construction, and the robotization of orbital collecting (MSTU);

- The dynamics, strength, and heat stability of the constructions, research in the field of the structural dynamics of space apparatus (MSTU);

- The development of new designs for space construction utilizing fabric and tape, balloons and probes for research on planetary atmosphere (MSTU);

- Research on the planning of automated planetary voyages; development of means of transport and robo-technological guidance systems (LMI);

- Research on the scientific bases for the manufacture of materials aboard spacecraft (MSTU);

- Research on the construction of space energy systems utilizing solar, nuclear and thermo-nuclear means (MSTU);

- Research in the field of laser space-link systems and multichannel space-based information systems (MSTU);

- Research on heat mass exchange processes and nozzle unit gasodynamics (MSTU);

- Research on fuel supply in conditions of weightlessness using coarse capillary equipment (NSTU);

- Research on meteorological and weather rocket design (NSTU).

3. Participation in carrying out international space programmes

3.1. The Shternberg State Astronomy Institute of Moscow State University has proposed a project in the field of space astrometry for the purpose of producing a high-detail catalogue of the coordinates (0.002 seconds of angle), parallaxes and independent movement of stars. SHAI MSU is interested in international cooperation on the "Lomonosov" project and prepared to consider scientific and technical proposals for cooperation within the framework of the project.

3.2. In recent years SCO MEI together with MEI and other State educational organizations of the USSR have taken an active part in the work of developing public education in the USSR in terms of the introduction of new information technology in the educational field under the interested observation of UNESCO.

3.3. The Special Design Office of the Moscow Energy Institute is prepared to design, launch and track specialized satellites for projects by foreign countries which do not possess their own appropriate base.

The mass of the satellites may range from 50 to 1,500 kg, depending on the orbit required; the orbits may be circular, at altitudes between 200 and 3,000 km, highly elliptical or geostationary at an altitude of 35,000 km. The foreign client's on-board equipment may be installed in any of three ways:

- On board a satellite manufactured and supplied by the client (with a guarantee of no unauthorized access), which will be launched by a Soviet carrier rocket and tracked from the Medvezh'e Ozero launch site;

- In the form of a payload (satellite) installed on a satellite platform manufactured in the USSR;

- In the form of a secondary payload installed on a Soviet satellite.

The foreign client's technical specialists may participate in all phases of the satellite's preparation, launch and subsequent control and guidance (from the Medvezh'e Ozero site), and in the data acquisition and processing.

3.4. The Special Design Office of the Moscow Energy Institute is prepared to carry out practical work on the implementation of international projects for the utilization of outer space using the launch sites and equipment belonging to the Institute.

3.5. At the Teaching and Scientific Museum of Physical Geography at Moscow State University, teaching and scientific work is carried out on the methodology for processing and analysing space information for use in physical geography and environmental sciences. The Museum has a sector on physical geography from space and rational utilization of nature in which technical facilities for processing video information are available. Classes are conducted with students of the Environmental Sciences Department using the technical facilities for processing video data, as well as study classes with future astronauts enrolled at the Y. A. Gagarin Astronaut Training Centre.

The Physical Geography Museum at Moscow State University has accumulated a certain body of experience in training specialists in environmental and ecological studies which involve the use of space information. There is a proposal to establish in the museum a teaching and scientific centre on "Geodynamics and Physical Geography from Space" which would work in the interests of nature conservation, rational utilization of natural resources and ecology, and would also train Soviet and foreign specialists in thematic analysis of space information in physical geography.

3.6. The N. E. Bauman Moscow State Technical University is planning to conduct fundamental and research work on the problems of solar-laser power sources for converting extra-atmospheric solar radiation into laser-beam energy, transmitting it to ground receiving stations or other objects in space and converting it into

electrical current. These sources can be used both to solve the overall problems of energy supply on Earth and to deliver power to local objects in space and facilities on Earth.

It is proposed that co-operation in this area should be conducted on the following topics:

- Development of the concept of constructing solar energy stations in space to transmit power to Earth;

- Study of the physico-chemical processes of converting solar radiation energy into laser radiation and developing a mock-up laser with a solar pump;

- Developing a physical model and investigating thermal emission plasma-optical converters for transforming laser radiation into electrical current.

3.7. The N. E. Bauman Moscow State Technical University is prepared to participate in international co-operation on the following topics: technology for the storage and utilization of drinking water in space, technology and instruments for using water as a structural or construction material and as a binder, modelling of the dynamics of phase transitions in three-phase jets and back-condensation onto a cold surface, and discharge of water into space on board space objects. Theoretical and experimental studies under ground conditions and experiments in space can be conducted.

3.8. The Moscow State University is engaging in a large body of research related to the study of outer space and space experiments in the following fields: high-speed aerodynamics, software for powerful computer systems, physics of space and cosmic rays, space astronomy, image processing in space research, space biology, use of space information for mapping, study and ecological assessment of the natural environment, etc.

3.9. The Nuclear Physics Research Institute of Moscow State University and the Nuclear Physics Section in the Physics Faculty are conducting a broad range of work on the experimental and theoretical study of physical processes:

- Experimental study of the chemical composition of primary cosmic rays (10^{12}-10^{15} eV) on Soviet satellites and study of processes of their acceleration and propagation;

- Experimental and theoretical study of the radiation pattern and physical phenomena in circumterrestrial space which affect the operation of satellites' on-board systems;

- Experimental and theoretical studies of the chemical composition and acceleration and propagation processes of solar cosmic ray particles in interplanetary space;

- Study of the mechanisms of magnetosphere-ionosphere interaction, including indirect measurements in space.

The Nuclear Physics Research Institute of Moscow State University has the necessary experimental base (including for the conduct of satellite-born experiments), a high level of theoretical capability, and experience in training specialists in these areas of space physics.

III. TRAINING OF SPECIALISTS IN THE EDUCATION FIELD

1. A number of higher educational scientific institutions (Moscow State University, Moscow State Technical University, the Moscow Energy Institute, the Moscow Aviation Institute, the Leningrad Mechanical Institute and others) can provide training for foreign post-graduate and undergraduate students and specialists in fields that contribute to the conduct of work on the utilization of outer space for peaceful purposes, send specialists and students to study in foreign higher educational institutions and also offer the possibility of exchanging specialists and young scientists to undergo training and improve their qualifications at foreign scientific centres.

2. The Moscow State Technical University considers that the most practical type of interaction, which will make it possible to pave the way for contacts as to the training of specialists and the conduct of research, is exchange of specialists and post-graduate and undergraduate students.

3. The P. K. Shternberg State Astronomy Institute at Moscow State University is the basic institute for training undergraduate and post-graduate students of the Astronomy Department of the Moscow State University Physics Faculty. The Institute trains specialists in all branches of astronomical science. It is interested in developing cooperation on astronomy with foreign institutes of higher education and scientific centres. It is prepared to accept every year two or three foreign graduate students and trainees specializing in astronomy and space research.

4. The Special Design Office of the Moscow Energy Institute has from the time of its establishment in 1948 been developing and producing electronic systems and equipment for space research; over the years, the Institute has acquired great experience in this area, as well as experience in the training of relevant specialists.

The Institute can render substantial assistance in the conduct of international cooperation on the study and utilization of outer space and the organization of professional training and education in this field.

The Institute has a staff of highly qualified workers who in addition have experience in teaching at the Institute, and some of them are able to give classes in English. The technical equipment of the Institute and its branches affords the possibility of conducting practical studies and research work at the most modern level.

In addition, the presence at the Medvezh'e Ozero branch of space communications equipment means that direct communication lines can be organized there which can be used to establish full-time information exchange channels with similar organizations abroad.

5. Organization of an international teaching centre on the basis of the Medvezh'e Ozero branch of the Special Design Office of the Moscow Energy Institute.

5.1. Topics of educational, practical and research work:

- means and methods of investigating remote outer space;
- means and methods of investigating planets, their satellites and comets within the solar system;
- means and methods of satellite tracking, guidance and control;
- space technology hardware and software;
- history of the development of space research technology.

5.2. Number of foreign students (with accommodation at the Medvezh'e Ozero branch hotel) - up to 35 at any one time. As this activity expands, the number of students could be increased, depending on financing (for the construction of a new hotel).

5.3. Classes can be conducted year round and/or in the form of short courses lasting 10-15 days.

5.4. If similar centres are established based at other organizations or abroad, instruction can be given under general programmes with constant exchange over space communication channels.

6. Organization of international scientific and technical seminars on issues relating to the study of outer space at the Medvezh'e Ozero branch of the Institute. (The subjects, conditions for holding the seminars and number of foreign participants accommodated at the branch's hotel are as indicated in sections 5.1-5.4 above.) Seminars can also be conducted addressed to an international audience, using direct space communication channels.

7. Conduct of international summer science schools for teachers and students under the general programmes and jointly with the American Space Academy (ASA), the American Space Society (ASS), the American Institute of Aeronautics and Astronautics (AIAA), the Flight Control Centre, the Cosmonaut Training Centre in Zvezdny Gorodok, etc.

8. The Moscow State University could consider proposals for study by foreigners in the following subjects:

(1) High-speed aerodynamics;

(2) Aerospace simulators;

(3) Computer diagnosis and processing of images in space research;

(4) Development of software for powerful computer systems;

(5) Experimental and theoretical studies of physical processes in outer space;

(6) Training of biologist-astronauts to conduct embryological experiments on board orbital stations;

(7) Space astronomy.